This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 965 756 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.12.1999 Bulletin 1999/51

(51) Int Cl.^{6}: **F04C 18/16**

(21) Application number: **99304667.1**

(22) Date of filing: **15.06.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **17.06.1998 GB 9813048**
07.07.1998 GB 9814659

(71) Applicant: **The BOC Group plc**
Windlesham Surrey GU20 6HJ (GB)

(72) Inventors:
- **Schofield, Nigel Paul**
Horsham, West Sussex, RH12 2NT (GB)
- **North, Michael Henry**
Reigate, Surrey, RH2 7DA (GB)

(74) Representative: **Bousfield, Roger James et al**
The BOC Group plc
Chertsey Road
Windlesham Surrey GU20 6HJ (GB)

(54) **Screw pump**

(57) A screw pump comprising a first shaft and spaced therefrom and parallel thereto a second shaft mounted in a pump body, a first rotor mounted on the first shaft and a second rotor mounted on the second shaft, each rotor having formed on an outer surface at least one helical vane or thread, the helical vanes or threads intermeshing together so that rotary movement of the shafts will cause a fluid to be pumped from an inlet towards an outlet of the pump, and in that a first bearing arrangement is associated with the first shaft and a second bearing arrangement is associated with the second shaft, a bearing carrier being provided for each bearing arrangement the bearing carriers each being mounted to the pump body but independently one from the other.

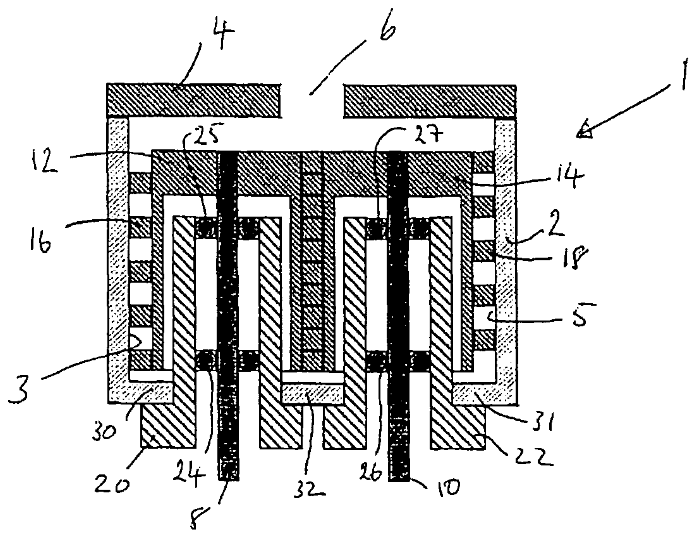

Figure 1

EP 0 965 756 A2

Description

[0001] The present invention relates to vacuum pumps and more particularly to screw pumps.

[0002] Screw pumps usually comprise two spaced parallel shafts each carrying externally threaded rotors, said shafts being mounted in a pump body such that the threads of the rotors intermesh. Close tolerances between the rotor threads at the points of intermeshing and with the internal surface of the pump body, which acts as a stator, causes volumes of gas being pumped between an inlet and an outlet to be trapped between the threads of the rotors and said internal surface and thereby urged through the pump as the rotors rotate.

[0003] Such screw pumps are potentially attractive since they can be manufactured with few working components and they have an ability to pump from a high vacuum environment at the inlet down to atmospheric pressure at the outlet.

[0004] Conventional screw pumps with shafts which are either mounted cantilever fashion within the pump body or supported at each end with bearings use a common head plate or plates to support the bearing or bearings of both shafts. The head plate or plates are then fixed to the pump body.

[0005] This construction has several disadvantages, for example, the head plate(s) has to be or is usually cooled to keep the bearing within its operating temperatures. However, the pump body (stator) is often run much hotter particularly on screw pumps used in semiconductor manufacturing processes. This gives rise to differential thermal expansion such that the stator bores move apart but the head plate and bearings and therefore the rotors do not move as far and become off-centred relative to their respective bores. This requires the screw pump to be made with large running clearances to prevent or minimise the possibility of seizure. Further, accurate centring of the shafts and rotors within the bores is also difficult due to the tolerance stack-up of the bearing centres and the positioning of the head plate relative to the stator which is typically effected with doweling.

[0006] It is an aim of the present invention to provide a screw pump which prevents or mitigates against the problems associated with conventional screw pumps and in particular the problem of thermal distortion.

[0007] According to the present invention a screw pump comprises a first shaft and spaced therefrom and parallel thereto a second shaft mounted in a pump body, both shafts adapted for axial counter-rotation relative to each other, a first rotor mounted on the first shaft and a second rotor mounted on the second shaft, each rotor being formed on an outside surface with at least one helical vane or thread, the helical vanes or threads intermeshing together so that rotary movement of the shafts will cause a fluid to be pumped from an inlet towards an outlet of the pump, and in that a first bearing arrangement is associated with the first shaft and a second bearing arrangement is associated with the second shaft, a bearing carrier being provided for each bearing arrangement, the bearing carriers each being mounted to the pump body independently one from the other.

[0008] In a preferred embodiment the rotors are hollow and a bearing carrier extends within each hollow rotor.

[0009] The bearing carriers should be mounted in the pump body in a manner such that centring of the bearings, and hence the shafts held in the bearings, is achieved despite thermal expansion of the pump body due to changes in working temperature of the pump body. This can be achieved in particular by attaching at least one end/edge of each bearing carrier to that part of the pump body which acts as the pump stator, normally that part which is parallel (or substantially parallel) to the pump/shaft main axes.

[0010] Each rotor may be substantially cylindrical or alternatively may be tapered in a direction from the inlet of the screw pump towards the outlet.

[0011] For a better understanding of the invention, reference will now be made, by way of exemplification only, to the accompanying drawings in which:

Figure 1 is a cross-section through a screw pump according to the invention;

Figure 2 is a cross-section through an alternative screw pump of the invention having tapered screw rotors; and

Figure 3 is a diagrammatic section, not to scale, through the pump body of the pumps illustrated in Figures 1 and 2.

[0012] With reference to Figure 1, a vacuum screw pump 1 includes a pump body 2 having a top plate 4 in which is formed an inlet 6. The pump body 2, for a major portion of its length, effectively comprises two overlapping bores 3, 5 which define between them an internal "figure-of-eight" shaped cavity (see Figure 3) within the body 2.

[0013] Located within the pump body 2 that, is within the bore 3, is a first shaft 8 and spaced therefrom and parallel thereto a second shaft 10 in the second bore 5. Mounted for rotary movement with the first shaft 8 within the pump body 2 is a first rotor 12 and mounted for rotary movement with the second shaft 10 within the pump body 6 is a second rotor 14. The two rotors 12, 14 are generally cylindrical in shape and on the outer surface of each rotor there is formed a continuous helical vane or thread 16, 18 which vanes or threads intermesh at the pump centre as illustrated.

[0014] The rotors 12, 14 are both hollow and accommodated within each hollow rotor are bearing carriers 20, 22. The bearing carriers are each attached and sealed to the pump body 2 by bolt means (not shown) independently one from the other. As shown in Figure

1, this is achieved by reducing the diameter of the bores 3 and 5 at the locations 30, 31 respectively so that they become independent and nonoverlapping to create a complete flange 32 to which the bearing carriers 20, 22 can be sealed.

[0015] As shown each bearing carrier 20, 22 contains a bearing arrangement comprising two spaced bearings, 24, 25 and 26, 27 for supporting the respective shafts 8, 10.

[0016] The shafts 8, 10 are adapted for rotation within the pump body 2 about their longitudinal axes in contra-rotational direction by virtue of the shaft 8 being connected to a drive motor (not shown) and by the shaft 10 being coupled to the shaft 8 by means of timing gears in a manner known per se.

[0017] In use, both shafts 8, 10 rotate at the same speed but in opposite directions. The fluid to be pumped will be drawn through the inlet 6 in the top plate 4 and will be pumped by means of the rotating rotors towards an outlet (not shown) in a manner known per se. The overall shape of the rotors 12, 14 and in particular the vanes or threads 16, 18 relative to each other and also relative to the inside surface of the pump body 2 are calculated to ensure close tolerances with the fluid being pumped from the inlet 6 towards the outlet as hereinbefore described.

[0018] In the above described embodiment it will be observed that the bearing carriers 20, 22 are fixed directly to the pump body 2 thereby removing the need for a conventional head plate. As the pump body 2 heats up, both the bores 3 and 5 and the bearing carriers 20, 22 move apart but keeping the rotors 12, 14 centred. It will be evident that the shafts 8, 10 must be rigidly supported and mounting the bearings carriers 20, 22 directly to the pump body 2 increases the rigidity of the general arrangement.

[0019] To enable the two independent bearing carriers 20, 22 to be sealed to the pump body 2 it is expedient for the two bores 3 and 4, which overlap each other for a major portion of the length of the pump body 2 (see Figure 3) to be reduced in diameter where to rotors 12, 14 are mounted and to become independent bores for the last few millimetres to create a complete flange 32 for the bearing carriers 20, 22 to seal to as shown. This flange or web links the two sides of the pump body 2 further increasing its stiffness and also increasing the area available to fasten and seal the bearing carriers.

[0020] In an alternative embodiment, the rotors 12, 14 may have a tapered screw form with the taper reducing from the end adjacent the inlet 6 towards the outlet. Figure 2 shows such an embodiment and uses generally the same reference numbers as those used in Figure 1.

[0021] With reference to Figure 2, the overall shape of each rotor 12, 14 is frusto-conical and tapers from the pump inlet 6 to the pump outlet (not shown). In this respect, it should be noted that it is the thread 16, 18 diameter of each rotor which decreases gradually in the direction of the pump inlet 6 to the pump outlet whereas the root diameter (rotor minus thread) will gradually increase in the same direction.

[0022] The carriers 20, 22 for the bearings 24, 25 and 26, 27 are of different design to those of the embodiment of Figure 1; however, they again are mounted on the body 2 on the flange 32 independently of each other and again allowing in particular, in use of the pump for a centring of the shafts 8, 10 and the rotors 12, 14.

Claims

1. A screw pump comprising a first shaft and spaced therefrom and parallel thereto a second shaft mounted in a pump body, a first rotor mounted on the first shaft and a second rotor mounted on the second shaft, each rotor having formed on an outer surface at least one helical vane or thread, the helical vanes or threads intermeshing together so that rotary movement of the shafts will cause a fluid to be pumped from an inlet towards an outlet of the pump, and in that a first bearing arrangement is associated with the first shaft and a second bearing arrangement is associated with the second shaft, a bearing carrier being provided for each bearing arrangement the bearing carriers each being mounted to the pump body but independently one from the other.

2. A screw pump according to Claim 1, in which the rotors are hollow and a bearing carrier extends within each hollow rotor.

3. A screw pump according to Claim 1 or Claim 2 in which each bearing carrier accommodates a bearing arrangement comprising two spaced bearings.

4. A screw pump according to any one of Claims 1 to 3 in which each rotor is substantially cylindrical.

5. A screw pump according to any one of Claims 1 to 3 in which each rotor tapers from a larger diameter towards the pump inlet and a smaller diameter towards the pump outlet.

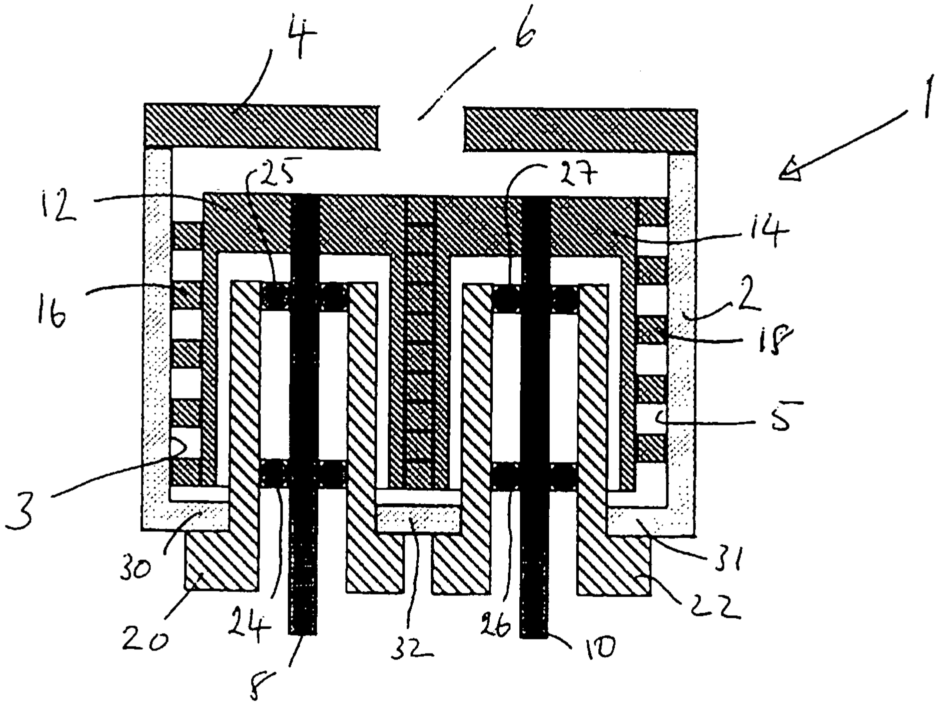

Figure 1

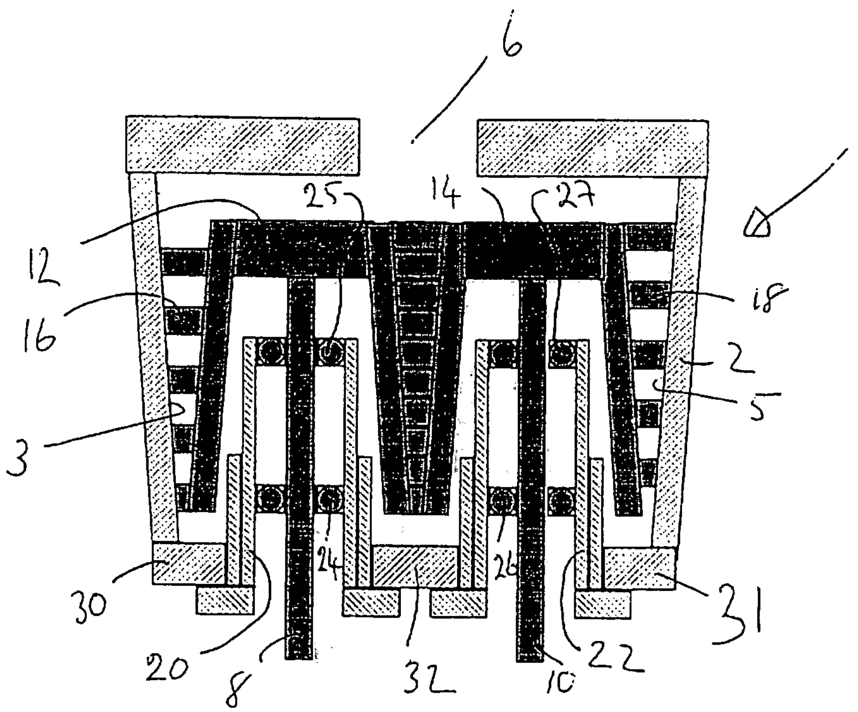

Figure 2

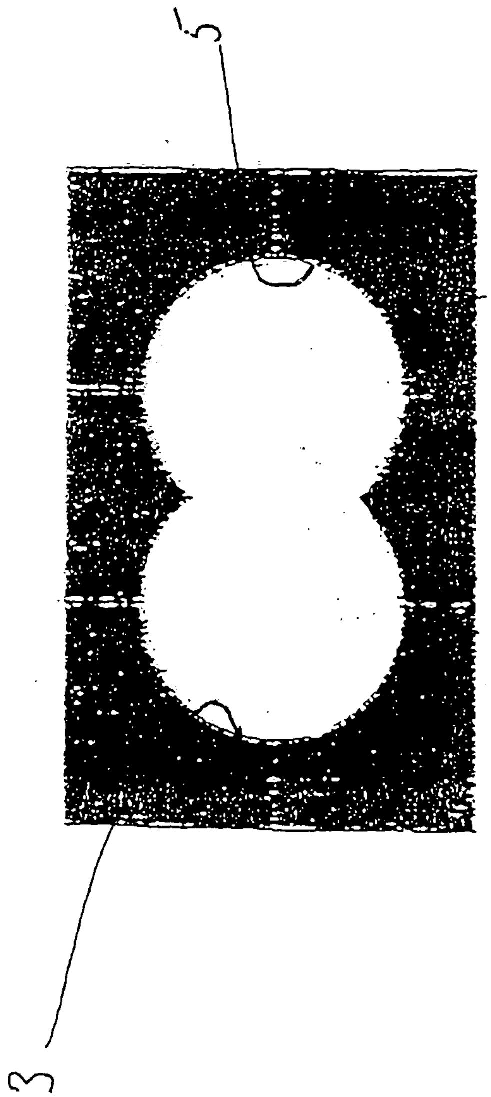

FIGURE 3